* Some Nigeria Students' Performance in Practical and Theoretical Chemistry Tests as Predictors of their Performance in MOCK-SSCE Chemistry Examinations

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Abstract: This study adopted the expost facto design in which the results of some Nigeria students' practical knowledge of Chemistry and their tests of theoretical knowledge of Chemistry were used to predict their performance in MOCK-SSCE Chemistry. The Senior School Certificate Examination (SSCE) is a terminal examination while the internal or State qualifying examination set after the pattern of SSCE is called MOCK-SSCE. Out of 33 schools in Ogbadibo LGA of Benue State Nigeria, only 15 schools met the requirements for selection as a science secondary school. Eight of these schools with a science student population of 128 were randomly selected and used as sample for this study. The instruments used for this study were the students' alternative to test of practical knowledge of Chemistry (SATPKC) and the students' tests of theoretical knowledge of Chemistry (STTKC). These instruments developed by the researchers had reliabilities of 0.94 using Kuder Richardson ($K\text{-}R_{21}$) for SATPKC and .89 for STTKC. Using multiple regression analysis the result shows that students' performance in a test of theoretical knowledge in Chemistry does not significantly predict their performance in MOCK-SSCE Chemistry theory examination. SATPKC could not significantly predict MOCK-SSCE mean practical scores. The over all relationship between SATPKC, MOCK-SSCE practical and MOCK-SSCE theory was not significant ($F_{2, 127}$ =1.644, p> .05). STTKC could not significantly predict mean MOCK-SSCE practical examination scores. Similarly, the overall relationship between STTKC, MOCK-SSCE practical and MOCK-SSCE theory mean scores was not significant ($F_{2, 127}$ = .177, p> .05). It was recommended that Principals of schools should ensure that science students carry out their lesson on practical weekly and at the same time relating it to theory as it will go a long way to enhance their performance during practical test. Similarly, school Principals and science teachers should ensure that theoretical aspect of Chemistry should be handled with all seriousness since it is as important as the practical aspect also.

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1. Introduction

Scientists and researchers like Oyekan (1999) saw science and technology as basic tools for industrial and national development. These if properly harnessed could bring about economic and social happiness by providing and improving the welfare of the citizenry. Consequently, the teaching and learning of science has become a great concern to scientists and researchers.

As people think about the teaching and learning of science in our schools, the picture of the state of Science and Technology in a country like Nigeria becomes glaring. This was expressed in the annual conference proceedings of Science Teachers Associations of Nigeria (STAN) in 1998 on the theme "winning more students for Science and Technology". This theme came as a result of poor performance by students in science examinations. This poor performance often resulted in poor enrolment of students in science at the secondary and tertiary institutions.

The poor performance of students could be attributed to a number of reasons including poor participation of students and poor level of exposure in the practical aspect of science especially Chemistry. Agbo and Mankilik (1999) quoted the then Minister of Education in Nigeria as saying that the performance of students in the sciences was not encouraging in spite of the huge amount of money expended on the purchase of science materials and equipment. Dajili (2001) also expressed his concern about the poor performance of students in science examinations. This concern arose from the increasing realization that the nation could not develop as rapidly as she aspired to without adequate tools of scientific and technological man power at all levels in her working populace. He (Dajili, 2001) maintained that the state of science at the secondary school level was very important. This is because the performance

at this level determines the quality and quantity of intake into the tertiary institutions in the country. This is why the performance in science examinations at this level as observed by Agbo and Mankilik (1999) and Dajile (2001) should be investigated.

The natural sciences (Biology, Physics and Chemistry) have two components, the theory and the practical aspects which make the teaching and learning of science real. Over the years report shows that candidates do not perform well in practical aspect. Ministry of Education (2001) and WAEC Chief Examiner's Report (2002) attributed the poor performance especially in practical aspect of Chemistry to their non-familiarity with the use of simple laboratory equipment, imprecise statement, spelling errors, inadequate exposure to laboratory techniques, lack of observational skills, inability to determine mole ratio from stoichiometric equations, omission of units in calculated values, inability to write symbols properly and assign correct charges to ions, among others. In the theory paper, poor performance of students was also attributed to a number of reasons which include their inability to represent simple reaction by balanced equations, violation of the convention for IUPAC nomenclature, tendency to crowd their answers together, poor spellings, definitions and diagram, non-familiarity with some contents of the syllabus, lack of depth and precision in the responses to essay questions, inadequate understanding of the fundamental principles in Chemistry, inability to distinguish between physical and chemical properties and incompetence in basic Mathematics and other factors that affect students performance in Chemistry. Whether these differences identified could affect students' performance in practical and theory examinations in Chemistry and whether students' performance in the tests of practical and theoretical knowledge of Chemistry could predict their performance in MOCK-SSCE practical and theory Chemistry examinations are not yet certain. The Senior School Certificate Examination (SSCE) is a terminal examination while the internal or State qualifying examination set after the pattern of SSCE is called MOCK-SSCE. MOCK-SSCE is therefore an examination that makes mockery of the SSCE or made to look exactly in content and cognitive requirements as the SSCE. This implies that all things being equal, those who pass well in MOCK-SSCE are expected to pass well in the SSCE also and vice versa. Achor, Aligba and Omananyi (2010) however stressed the fact that previous studies in Nigeria have not given much consideration to the need to examine the extent to which different examinations meant for graduating secondary school students in the sciences could predict one another.

Students write examinations in MOCK-SSCE and SSCE yearly. Such students' results in SSCE and MOCK-SSCE are often sent down in comprehensive form in the final grade to schools. The scores of students in test of practical and theory aspects are not shown. However, in MOCK-SSCE conducted by the State, the raw scores of the two aspects of Chemistry could easily be obtained separately from the Ministry of Education to allow for comparison of the students' performance in the two major aspects of Chemistry examinations. In MOCK-SSCE, students are tested in theory of practical (i.e. alternative to practical) knowledge instead of the real practical work. Could the results of students obtained in the test of practical and theoretical knowledge of Chemistry predict their performance in MOCK-SSCE? It is against this background that the researchers undertake this study to find out if the students' performance in tests of practical and theoretical knowledge of Chemistry could predict their performance in MOCK-SSCE.

2. Statement of the Problem

The rate at which students fail in science examinations (Chemistry inclusive) pose a lot of threat not only to science teaching and learning but also technological development in Nigeria both now and in future. Some factors may be responsible for the massive failure of students in these science examinations. These factors could be in the area of man power needs, quality and quantity of staff; the nature of our laboratories in terms of materials and equipment for effective teaching and learning of science and extent to which practical are conducted. This therefore, calls for urgent attention and solutions by Government and all the stake holders in the science education. Olotu (1999) observed also that in the senior secondary schools in Nigeria where basic principles of sciences are taught in preparation for further education, many students are not interested in the practical aspect of the sciences. During the theory lessons, students may like to participate fully but when it comes to practical aspect of the subject, they become reluctant and often have to be persuaded to participate. This behaviour according to Busari (1999) and Ali (2003) is traceable to inadequate number of materials and equipment available for the teachers to conduct practical for students at the appropriate time.

Many students in Ogbadibo Local Government Area of Benue State Nigeria do not offer Chemistry as a subject especially the females (Benue State Examinations Board Makurdi, 2006). What could be responsible for these observed trends? Could this be a result of inadequate number of man power to handle the course or materials or inadequate exposure to Chemistry practical? More worrisome is the fact that

there is no known empirical evidence in support of the fact that students are faring well in both theory and practical aspects of chemistry and that doing well in one could be an indication of doing well in the other aspect in the selected study area. The problem of this study put in question form therefore is, to what extent could students' performance in tests of practical and theoretical knowledge of Chemistry predict their performance in MOCK-SSCE?

3. Research Questions and Hypotheses

The following research questions and hypotheses guided the study:

RQ: What is the mean performance pattern of SS 2 students in tests of practical and theoretical knowledge of Chemistry as well as their MOCK-SSCE practical and theory Chemistry examinations?

Ho1. SS 2 students' performance in a test of practical knowledge in Chemistry does not significantly predict their performance in MOCK-SSCE Chemistry practical examination.

Ho2. Students' performance in a test of practical knowledge in Chemistry does not significantly predict their performance in MOCK-SSCE Chemistry theory examinations.

Ho3. Students' performance in a test of theoretical knowledge in Chemistry does not significantly predict their performance in MOCK-SSCE Chemistry practical examination.

Ho4. SS 2 students' performance in a test of theoretical knowledge in Chemistry does not significantly predict their performance in MOCK-SSCE Chemistry theory examination.

4. Theoretical Frame Work for this Study

The cognitive (Gestalt) theorists define learning as a development of insight. It states that learning involves personal involvement, re-organization of perceptions and gaining of insight in a purposeful activity (Okoye, 1998). This theory which is also called insight theory of learning emphasizes the importance of organization of activities in the psychological field. It states that with numerous experiences the learner fixes the new experiences in the old and reorganizes the old in terms of new events and perceives significant factors involved (Hartmann, 1935). According to this theory, all problems are solved as soon as the learner achieves insight into their essential relationship. Learning does not occur through trial and error or conditioned stimuli, but rather occurs in a flash of lightening and sheds light on the problem as a whole. It is creative and akin to invention. It is a fact that insight learning depends on previous learning or experiences. This however, will occur if the ground is prepared for, by trial and error. The concepts learnt in theoretical aspect of Chemistry would condition insightful learning relevant to the practical work in Chemistry. The teacher as a facilitator has to guide, motivate and attempt to capture the attention of the leaner for insightful learning to take place.

The theory of transfer of learning hinges on the ability of individual to transfer the knowledge gained or acquired in one situation to another. This theory is very important in this study since we expect students to use their experiences gained in the theory aspect of Chemistry (or other science subjects too) to solve problems in the practical aspect of the course. A number of theories have been advanced on the mechanism of transfer of learning. These are the theory of identical elements; theory of generalization and the theory of similar though not identical elements (Thorndike, 1916). Thorndike conducted his experiments on identical elements in 1904. On the basis of his experiment, he found that transfer occur from one situation to another because of the presence of identical elements. These identical elements are grouped as identities of substance (matter) and identities of procedure (method). This theory is important here as it applies to some aspects in Chemistry. Thus, the knowledge gained in the theoretical aspect should improve students' performance in practical Chemistry. There are at least some elements of similarity or identity and it could therefore be possible to have transfer of learning. Although these theories do not give us the causes of transfer of learning, the descriptions are relevant to our education practice especially as it relates to Chemistry and other sciences.

Relating these theories to this study, for students to perform well in Chemistry which is one of the major components of science, they will have to be personally involved in both practical and theoretical aspects of the course. The students have to be familiar with some of the concepts in the sciences, gain insight into the learning processes, be acquainted with the materials and equipment in the laboratory. This would enhance their skills in manipulating these materials or equipment for a meaningful end result. The theorists emphasized the importance of exercises. The teacher should, therefore, engage the students in gainful exercise such as weekly practical work which could help them to develop their skills, hence better performance.

5. Research Methodology

This section addresses the design, population, sample and sampling as well as the instruments. Validation and procedure for data collection were discussed.

Design

This study has adopted the expost facto design. This is due to the fact that the researcher intends to identify the level which one variable can predict a second related variable and the respondents were not subjected to treatment but simply after what they know already. In this study; the researcher used the results of students' alternative to practical knowledge of Chemistry and their tests of theoretical knowledge of Chemistry to predict students' performance in Chemistry in MOCK-SSCE.

Population, Sample and Sampling

The population of the study consists of all senior secondary school 2 science students from Government owned schools, grant – aided schools and privately owned schools that offer Chemistry in WAEC and NECO SSCE. SS 2 Chemistry students were used for this study. The criteria for selecting the population of the study were that the schools must have presented students for MOCK-SSCE in Chemistry for at least four years. MOCK-SSCE Examination is written in Benue State by only SS 2 students.

There are 33 schools in the Local Government Area with a total population of 374 science students. Out of these 33 schools only 15 schools met the requirement for selection as a science secondary school. Eight of these schools with a science student population of 128 were randomly selected and used for this study. The criteria used for the selection of these schools include the fact that at least two of the schools must be from each of the three districts that constitute the study area, (2) the schools must offer all the three science subjects (Biology, Chemistry and Physics), (3) the schools must have also presented students for SSCE for at least four years and must represent at least one of the three types of ownership already mentioned. It is on these bases that the eight schools were selected. In this study, 128 students (64 males and 64 females), that is, about 65% of the total population of 197 were used and have equal representation in the sampled schools. Proportional random sampling technique was adopted to select the male and female students from the different schools. This is because this method of sampling gives each member of the population a fair and equal chance of being chosen.

Instruments, Validation and Reliability Coefficients

The instruments used for this study were the Students' Alternative to Test of Practical Knowledge of Chemistry (SATPKC) and the Students' Tests of Theoretical Knowledge of Chemistry (STTKC). These instruments were developed by the researcher and administered to the SS 2 science students.

Section A of SATPKC contains personal data of the respondents. Section B consists of 20 questions on students' alternative to tests of practical knowledge of Chemistry (SATPKC). Each question has four options lettered A – D. The respondents were asked to choose the correct option by circling the letter that bears the correct option.

Section B of STTKC also contains 20 items while section A contains the personal data. Each item has four options lettered A – D. The respondents were asked to choose the correct option and circle the letter that bears the correct option.

MOCK-SSCE Examination is conducted in Benue State in all schools prior to May/June SSCE. The examination which is conducted centrally by Benue State Examination Board cuts across all subjects offered in the schools including Chemistry. The questions for this public and all important examination are generated during item writing workshops often organized by Benue State Examinations Board in conjunction with Teaching Service Board and Ministry of Education Headquarters, Makurdi. The questions so generated are kept in the questions Bank. Various subject teachers are used for the generation of these questions.

The questions, SATPKC and STTKC are set, taking into cognizance the bloom taxonomy of education and in accordance with the syllabuses of WAEC and NECO examination bodies.

To ensure the validity of the instruments, the following measures were employed. It was ensured that questions were not ambiguous, double barreled statements were avoided. Content and face validity were carried out by experts in science education with Table of specification attached. Specifically, three science education experts and one in measurement and evaluation did the validation.

The reliabilities of the instruments were established during the pilot study using test – retest method. It was administered in a school outside those sampled for the main study to 20 students. The reliabilities were calculated using Kuder Richardson K-R_{21} and was found to be .94 for SATPKC and .89 for STTKC. These values were considered good enough to warrant the use of the instruments for the main study.

Procedure for data collection and analysis

With the permission of the school principals and the assistance of the chemistry teachers, the questions on the two aspects of Chemistry (i.e. theory and practical) were administered by the researcher on the sampled students. The sets of scores from students' alternative to test of practical knowledge of Chemistry and students' test of theoretical knowledge

of Chemistry were collated. The performance scores of the students in MOCK-SSCE of the sampled students in these two areas were also collated.

The scores obtained from the respondents on the tests on alternative to practical knowledge of Chemistry and theoretical knowledge of Chemistry were correlated with the performance scores of students in MOCK-SSCE collected from Benue State Examinations Board, Makurdi. The data answering research questions were analyzed using the mean statistics. Multiple regression was used for analysis to determine the extent to which the dependent variable were predicted. Thus all the hypotheses were tested using the result from the multiple regression.

6. Results

Results in this study are presented in line with research questions and hypotheses.

Research Question One

What is the mean performance pattern of SS 2 students in tests of practical and theoretical knowledge of Chemistry as well as their MOCK-SSCE practical and theory Chemistry examinations?

Table 1. Mean and Standard deviation for students' performance in SATPKC, STTKC, MOCK-SSCE Practical and Theoretical chemistry examinations

Exam	Cases, N	Mean	Std. Deviation
SATPKC	128	8.2422	1.93495
STTKC	128	7.7188	1.78329
MOCK Pract.	128	10.8516	2.38132
MOCK Theory	128	7.4141	2.20425

Table 2. Predictive values of MOCK Practical and MOCK Theory on SATPKC from Multiple Regression

Exam	Beta value	T	Sig.
Constant	-	7.232	.000
MOCK Practical	.146	1.652	.101
MOCK Theory	-.057	-.643	.521

Dependent variable: SATPKC

Table 3: ANOVA of relationship between MOCK Practical, MOCK Theory and SATPKC

	Sum of Squares	Df	Mean Square	F	Sig.
Regression	12.190	2	6.095	1.644	.197
Residual	463.302	125	3.706		
Total	475.492	127			

*Predictors: Constant), MOCK Theory, MOCK Practical
*Dependent variable: SATPKC
* R^2 = .026

Table 4. Predictive values of MOCK Practical and MOCK Theory on STTKC from Multiple Regression

Exam	Beta value	T	Sig.
Constant	-	7.625	.000
MOCK Practical	.030	.336	.737
MOCK Theory	.046	.512	.610

Dependent variable: STTKC

Table 5: ANOVA of relationship between MOCK Practical, MOCK Theory and STTKC

	Sum of Squares	df	Mean Square	F	Sig.
Regression	1.141	2	.571	.177	.838
Residual	402.734	125	3.222		
Total	403.875	127			

*Predictors: Constant), MOCK Theory, MOCK Practical
*Dependent variable: STTKC
*R^2 = .003

Table 1 reveals that students consistently performed better in tests of practical both in researcher made test (SATPKC) and MOCK-SSCE, that is, 8.2422 and 10.8516 respectively. In general performance in MOCK-SSCE was better than in SATPKC and STTKC with higher standard deviation (2.38132 and 2.20425) compared to standard deviations of 1.93495 and 1.78329 which by implication means that there was higher distribution of scores (far) from the mean in MOCK-SSCE practical and theoretical examinations.

Hypothesis One (Ho_1): SS 2 students' performance in a test of practical knowledge in Chemistry does not significantly predict their performance in MOCK-SSCE Chemistry practical examination

Table 2 shows that't' value of 1.652 is only significant at .101 which is higher than .05 (or 95% confidence level). This implies that SATPKC could not significantly predict MOCK-SSCE mean practical scores. The null hypothesis is therefore retained. Secondly, MOCK practical only contributed 14.6% (i.e. .146) of the total value.

Hypothesis two (Ho_2): Students' performance in a test of practical knowledge in Chemistry does not significantly predict their performance in MOCK-SSCE Chemistry theory examination.

With reference to Table 2, a value of -.643 is only significant at .521 which is higher than .05($p > 0.05$). Therefore MOCK-SSCE mean score could not significantly predict SATPKC. It could only contribute -.057 (-5%) to the total value. Table 3 equally reveals that the over all relationship between SATPKC, MOCK-SSCE practical and MOCK-SCE theory was not significant, $F_{2,127} = 1.644$, $p > .05$.

Hypothesis Three (Ho_3): Students' performance in a test of theoretical knowledge in Chemistry does not significantly predict their performance in MOCK-SSCE Chemistry practical examination.

Table 4 reveals that with the t value of .335 which is only significant at .737, it means that STTKC could not significantly predict mean MOCK-SSCE practical examination scores. It accounted for only 3% (i.e. .03) of the total value.

Hypothesis Four (Ho_4): SS 2 students' performance in a test of theoretical knowledge in Chemistry does not significantly predict their performance in MOCK-SSCE Chemistry theory examination.

Again Table 4 reveals that with a t value of .512 which is only significant at .610, it implies that STTKC could not significantly predict mean MOCK-SSCE theory scores at .05 level of significance. Similarly, the overall relationship between STTKC, MOCK-SSCE practical and MOCK-SSCE theory mean scores was not significant as pointed out in Table 5, $F_{2, 127} = .177$, $p > .05$.

7. Discussion of Findings

The focus of the study was to investigate students' performance in tests of practical and theoretical knowledge of Chemistry and how they could predict their achievements in MOCK-SSCE Chemistry in Ogbadibo Local Government Area of Benue State in Nigeria. This discussion is based on the findings of the 4 hypotheses.

The finding from hypothesis one shows that SS 2 students' performance in a test of practical knowledge in Chemistry does not significantly predict their performance in MOCK-SSCE Chemistry practical examination. This finding is in line with Usman (2000) who found that students' performance in practical activities does not significantly relate to their academic achievement. In disagreement with this finding, is the work of Maduabum and Madubuike (1999) that practical activities help the students retain what is learnt and also better understanding that could help him improve in academic performance. Implication of this finding could be that either adequate practical are not conducted in these schools or that not much of the content is covered. Which ever way, it appears odd to note that the two examination scores in the same (that is, chemistry) subject departs from one another significantly. This also is a pointer to poor performance in chemistry at the SSCE. It is difficult to pass a subject when one performs poorly in a major aspect of it.

The second finding in this study revealed that SS 2 students' performance in a test of theoretical knowledge in chemistry does not significantly predict their performance in MOCK-SSCE Chemistry theory examination. This finding disagrees with Ifejika (1990) who in his work on achieving better results in integrated science through redefining and re-orienting practical and theory work found that students perform better if and only if they understand the practical and theory concepts in sciences. Thus, urges students to grasp the concepts of science subjects very well. Also, it contradicts the work of Tanier (1977) who affirmed that in science, both the theory and the practical aspects enhance students' academic performance and it helps to test how well a student understands the nature of scientific investigation and their ability in handling simple apparatus in an experiment to determine an answer to a practical question. The worry here is that if two examinations which are expected to measure the same level of knowledge and content for the same group of learners in the same aspect of Chemistry could not produce

same or similar results, then the matter is beyond expectation. Except something is fundamentally wrong, for instance, if examination malpractice was condoned in one of the examinations, one expects one exam to predict or be similar in score to the other for the same group of students.

Hypothesis three states that students' performance in a test of theoretical knowledge of Chemistry does not significantly predict their performance in MOCK-SSCE Chemistry practical examination. This hypothesis was investigated and the result shows that students' performance in a test of theoretical knowledge in Chemistry does not significantly predict their performance in MOCK-SSCE Chemistry practical examinations. This finding is in line with Idoko (2005) who affirmed that theoretical knowledge in science do not significantly influence students' performance in practical aspect of science. Also, in disagreement with this finding, is the work of Akpa (2005) who found that theoretical knowledge of science (Biology) enhances students' performance in the practical aspect of science. The deviation in this finding could probably be attributed to good supervision in the SATPKC and STTKC as opposed to what happens in MOCK-SSCE practical and theory examinations which are seen as do or die affairs as it dictates the transition from SS 2 to SS 3 in all secondary schools in Benue State of Nigeria. By implications supervision is more likely to through in SATPKC and STTKC compared to MOCK-SSCE.

Hypothesis four states that students' performance in a test of theoretical knowledge in Chemistry does not significantly predict their performance in MOCK-SSCE Chemistry theory examination. This hypothesis was investigated and the result shows that students' performance in a test of theoretical knowledge in Chemistry does not significantly predict their performance in MOCK-SSCE Chemistry theory examination. This finding attests to the fact that existing theories on the help of related knowledge assisting in understanding appears defeated. One expects that those who perform well in test of theoretical knowledge in chemistry should equally do well in theory examinations in MOCK-SSCE chemistry and vice versa. This deviation from what is known could be attributed to examination malpractice. If students were not allowed to cheat in STTKC but did in MOCK-SSCE theory examination, then it may not be possible for one result to predict the other. It is one thing for learners to be at the same academic level for two similar examinations, it is another thing for the two examinations to be written under dissimilar conditions.

8. Conclusion and Recommendations

Based on the findings of this research, it is concluded that neither students' score in test of practical nor theoretical knowledge in chemistry could predict their practical and theory MOCK-SSCE scores. As a follow up, the following recommendations were made:

1. The Principal of schools should ensure that science students carry out their tests of practical weekly. This will go a long way to enhance their knowledge during practical test.
2. School Principals should ensure that theoretical aspect of the science subjects especially Chemistry should not be handled with levity since it is as important as the aspect of practical.
3. Government should provide educational facilities and learning materials especially laboratory equipment to meet the needs of students during their tests of theoretical and practical in science particularly in Chemistry.

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